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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

PROGRESS REPORT OF A STUDY OF THE BLACK HILLS BEETLE EMERGENCE IN SOUTHEASTERN WYOMING SUMMER OF 1935

By

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U. S. Forest Insect Laboratory,
Fort Collins, Colorado,
March 9, 1936.

Dr. F. C. Craighead,
Bureau of Entomology and Plant Quarantine,
Washington, D. C.

Dear Dr. Craighead:

I am enclosing herewith a report by Whiteside "Progress Report of A Study of the Black Hills Beetle Emergence in Southeastern Wyoming - Summer of 1935"

I feel that with the very limited time which he had to devote to this project he has done a very creditable piece of work and that he has made a very good start on one of our most important problems at this station.

Probably the most important fact demonstrated by Whiteside's data is that emergence of the Black Hills beetle from limber pine is about 800 percent greater than from lodgepole pine in this region. He also obtained valuable data on the start, duration, and end of emergence at three elevations. The graphs show this rather well and they also show the peak of emergence and the comparative emergence from both limber and lodgepole pine.

I am sending copies of this report to the other western field stations and am enclosing an extra copy in case you desire to submit one to the Washington Office of the Forest Service. I am also holding at this office copies for the Regional Office and the Medicine Bow National Forest. I will forward these upon your approval. Ordinarily copies of these reports would not be furnished the local forest offices but in this case where they supplied most of the money for the study I believe it might be a good idea to furnish them reports. It would at least keep up their interest in our studies. We have a similar case in the report being prepared by Baumhofer and Hopkins on Ips studies in the Black Hills.

Of course we invite criticisms and suggestions from all those who care to make them.

Enclosure:

Very sincerely yours,

J. A. Beal,
Entomologist,
Forest Insect Investigations.

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ABSTRACT

Although this is a progress report of only one summers emergence of the Black Hills beetle in southern Wyoming, several interesting facts have been brought out concerning the behavior of this beetle. There follows a pointed analysis of the salient facts obtained in 1935. A complete summary will be found at the end of this report.

(1) The 1935 emergence of the Black Hills beetle from the lower bole of limber pine attacked in 1934 was about 800 percent greater than from lodgepole pine.

(2) A total of 4,606 beetles emerged from 28 square feet of the lower bole of limber pine. At the same time only 584 beetles emerged from 32 square feet of the lower bole of lodgepole pine.

(3) Emergence from the basal area of limber pine extended over a period of 47 days at 8,000 feet; 40 days at 9,000 feet; and 56 days at 10,000 feet elevation.

(4) Emergence from the basal area of lodgepole pine extended over a period of 34 days at 8,000 feet; 40 days at 9,000 feet; and 53 days at 10,000 feet elevation.

(5) Many adults emerge from trees in which they overwinter as larvae, make one new attack and reemerge during the same summer.

PROGRESS REPORT OF

A STUDY OF THE BLACK HILLS BEETLE EMERGENCE

IN SOUTHEASTERN WYOMING

SUMMER OF 1935

INTRODUCTION

Prior to the establishment of the forest insect laboratory in Region 2, there has been no accurate basis upon which to make recommendations for the most effective period of control work against the ravages of the Black Hills beetle (Dendroctonus ponderosae Hopk.) in the central Rocky Mountain Region. There was therefore, an active need for detailed information pertaining to the seasonal history and host relations of this tree-killer. In order to enhance our knowledge of some of these points and to obtain data upon which to make decisions in questions of control work - at least in southern Wyoming - a tree caging study was inaugurated in July 1935.

The objectives of this study were as follows:

(1) To obtain data on the comparative number of beetles emerging from limber and lodgepole pine.

(2) To determine the duration and peak of emergence.

(3) To obtain data on the possibility of parent adult emergence.

(4) To obtain information on associated insects - parasites, predators, scavengers, etc.

THE AREA

The area selected for this study was on Elk Mountain, Carbon County, Wyoming. This mountain, rising to a height of 11,162 feet and covered with a fair stand of lodgepole pine, Engelmann spruce, limber pine, and Douglas fir, is located 4 to 5 miles north of the Medicine Bow National Forest boundary. The Black Hills beetle infestation has reached epidemic proportions during the past two or three years. A recent survey revealed that approximately 79 percent of the infested trees were limber pine and only 21 percent were lodgepole pine, with the heaviest infestation on the south and entire west portion of the mountain. Since no control work has been attempted on the area, the situation, for our particular purpose, was ideal. Variations in elevation, tree species, site, and exposure were available. Photographs 1 and 2 show the relation of Elk Mountain to the Medicine Bow National Forest, and the west side of the mountain.

PROCEDURE

Fifteen trees, eight lodgepole and seven limber pine, were selected for caging. Five of these were at each of three elevations, eight, nine, and ten thousand feet (elevations estimated - approximate) on the southwest portion of the mountain. These trees form parts of groups of trees attacked in 1934 and were picked as being representative of the average condition. A t the time of installing the cages the bark on these trees, was not molested, but by examination on adjacent trees, it was assumed that the attacks and broods developing therein were typical.

On July 24 and 25, 1935 a total of 30 cages were placed on the selected 1934 - attacked trees to secure data on new adult emergence.

A second set, of 15 cages, was installed on August 30, 1935 on 12 newly attacked trees. These attacks started early in August, and while complete emergence from the overwintering trees had not yet occurred, this set was placed at this time for the singular purpose of ascertaining whether or not the attacking parent adults reemerged.

The number of caged trees at each elevation is as follows:

Elevation	Lodgepole pine	Limber pine
8,000 feet	5	4
9,000 "	4	4
10,000 "	4	6
	13	14

The cages were made from 16 mesh copper screen and cut to cover an area 2 feet long and 1 foot wide, or 2 square feet of bark surface. Attached to the bottom of the cage was a small removable collecting can into which the emerging beetles fell.

The first set of cages were held in place by wooden laths nailed up the long sides, with strips of cotton placed beneath the laths and under the screen on the short sides to insure a tight fit. Because of the lack of uniformity in tree trunks, some difficulty was encountered with this method. An improvement was made on the second set, by employing strips of galvanized iron. These were cut ½ inch wide by 12½ and 24½ inches long and could be pounded into the cracks of the bark, making the use of cotton packing unnecessary. With this method a tight cage was easily secured.

Photographs 3 and 4 show the arrangement of the cages on the tree, with the iron strips in use, and a close view of one cage.

COLLECTIONS

Although this study originally started as a Bureau of Entomology and Plant Quarantine project, after August 1, 1935 it was financed by the Forest Service. The collections had to be worked in with the general bark beetle survey on the Medicine Bow National Forest. Collections were made in most cases on week-ends, usually on Sunday. A separate vial was kept for each cage and as the insects were collected they were placed in this vial with the date of collection. Later they were sorted, counted, and stored in larger vials with 70 percent alcohol.

NEW ADULT EMERGENCE

Random field examinations in this region have often indicated that the Black Hills beetle population beneath the bark of limber pine is greater than in lodgepole pine. While both species appear to be attacked by approximately the same number of beetles per square foot, the number of individuals which complete their development and finally emerge from limber pine is very decidely greater than the number from lodgepole pine. Proof of this, is perhaps, the most outstanding fact obtained from this summer's experiment.

The number of beetles emerging from limber pine was approximately 800 percent greater than from lodgepole pine - using the emergence from lodgepole as a base. The total emergence from these

two host species attacked in 1934 is as follows:

Tree Species	Square Feet of Bark Caged	Total Number of Beetles Emerging	Average Number of Beetles per sq. ft.
Lodgepole pine	32	584	18.2
Limber pine	28	4,606	164.5

At the end of this report are included seven tables, chiefly significant as a record and reference for future collection and caging studies in this area. They are included so that the 1935 data will be complete. Table 1, from which the above summary was taken, shows the total number of beetles collected from all the cages on both species of 1934 - attacked trees. Table 4 for limber pine and table 5 for lodgepole pine, show the number of beetles collected on each visit to the caged trees, together with the percentages of the total emergence which these numbers represent. A summary of the data from these tables is given in table 6. To better illustrate this comparative emergence and to diagrammatically picture these results chart 1 is also included. It should be added that these totals, especially that of limber pine, do not represent the final number of beetles. Examinations made at intervals during the summer and late fall on trees adjacent to those caged, showed that, at 10,000 feet, pupae and callow adults were still under the bark when emergence was nearly over. It is possible that some of these beetles require more than one year to mature, depending on the elevation, and barring abnormal winter mortality some will emerge in the spring to give a higher emergence per square foot.

THE DURATION OF EMERGENCE

The second objective of this study was to determine the duration and peak of emergence. After installing the cages, 13 days elapsed before the first collection was made on August 7, 1935. At this time 40 percent of the total emergence from limber and lodgepole pine at 8,000 feet had taken place. Thus the date of the initial emergence was not obtained at this elevation but probably occurred five to six days earlier than that recorded. On August 7, 1935 the emergence at 9,000 feet was just starting. The first emergence at 10,000 feet from limber pine was on August 15, 1935 and from lodgepole pine three days later.

Charts 2 and 3 show, the percentages of the total emergence on the different collection dates for lodgepole and limber pine respectively. The results from the north and south cages have been plotted separately. From these two charts table 2 has been prepared, showing the dates and the number of days after the initial emergence on which important percentages of emergence took place. For the purpose of simplification there is given below a summary of table 2 in which the north and south data for both species have been averaged.

Elevation	Tree Species	50 % Emergence	75 % Emergence	90 % Emergence	95 % Emergence	100 % Emergence
8,000 ft.	LP	5	10	15	18	40
	LPP	4	9	15	18	29
9,000 ft.	LP	16	19	24	28	40
	LPP	9	16	21	23	40
10,000ft.	LP	15	21	27	30	54
	LPP	13	19	23	29	50

LP - Limber pine LPP- Lodgepole pine

These records show that from limber pine at 8,000 feet the final emergence averaged 14 days earlier - 9 days on the north and 19 days on the south side of the tree - than at 10,000 feet. From lodgepole pine the final emergence averaged 21 days - 23 on the north and 19 on the south - earlier at 8,000 feet than at 10,000 feet. It is also indicated that, after the start of emergence the same number of days were required for the final 10 percent of the total emergence as were required for the first 90 percent.

By plotting the total number of beetles collected from lodgepole pine on each date, the intensity and duration of emergence at the three elevations was obtained. This is shown in chart 4, and chart 5 gives the corresponding data for limber pine. It will be noted that much the same general pattern prevails for both host species at each elevation. After the start of emergence a sharp peak was reached, during which a greater percentage (70 - 80 percent) of the total emergence took place. This was followed by a smaller peak which preceeded the gradual decrease in the number of emerging beetles.

In attempting to explain the light emergence of August 15 and 18, occurring between the peaks of emergence shown in charts 4 and 5, only one logical reason can be offered. During this period the weather was quite cool and considerable rain fell, which probably caused the reduction in the number of emerging beetles.

Although cognizant of the role that weather, especially temperature, plays in the life of bark beetles, no attempt was made in this study to keep weather records, or to correlate weather with emergence.

PARENT ADULT EMERGENCE

The third phase of this study dealt with the possibility of parent adult emergence. Occasional holes have been noted at the ends of egg galleries in newly attacked trees, which indicated this possibility. Blackman* mentions the fact that some of the over-wintering parent adults emerge in the spring after completing their egg galleries. In order to obtain information on these points the second set of cages was installed. These were placed on one side of each tree after the new attacks were well under way, but before complete emergence from the old trees had taken place. It is planned to install cages on the opposite side of these same trees early in the spring.

Table 3 shows in detail the emergence of these parent adults. The following is a summary of all cages taken from table 3:

Tree Species	Square Feet of Bark Caged	Total Number of Parent Adults Emerging	Average No. per Sq. ft.
Lodgepole pine	14	39	2.7
Limber pine	16	50	3.1

Although only 30 square feet of bark were caged, the results to date indicate that a considerable number of parent adults re-emerge. The greatest number came from limber pine at 8,000 feet, where 38 emerged from 4 square feet, or 9.5 per square foot: 22 of this total came from 2 square feet. From lodgepole pine 13 parent adults emerged at each of the three elevations. Whether or not this is a factor to be considered in control practices remains to be seen after additional collections have been made from caged trees.

*Blackman, M. W., The Black Hills Beetle. New York State College of Forestry Vol. 4, No. 4, Nov. 1931. Tech.Pub.36,p 13.

EFFECT OF ELEVATION ON TOTAL EMERGENCE

This first years records failed to show a definite correlation between elevation and total emergence. From limber pine the heaviest emergence occurred at 8,000 feet, where 1,562 beetles emerged from 8 square feet, or 195.7 per square foot. The greatest number of beetles emerging from a single cage was 509 at 10,000 feet, with an average of 254 per square foot. The lightest emergence and the least number of beetles per square foot was at 9,000 feet where 909 beetles emerged from 8 square feet, giving an average of 113.6 per square foot. Only 81 beetles emerged from one cage at this elevation. The shaded north slope and exposure at which the trees at 9,000 feet are situated, may account for the lighter emergence.

The heaviest emergence from lodgepole pine occurred at 10,000 feet, where 254 beetles emerged from 8 square feet, or 31.7 per square foot. Two thirds of this total, or 154 beetles came from 2 square feet of bark. Here too, the lightest emergence and the smallest number of beetles per square foot occurred at 9,000 feet where 145 beetles came from 12 square feet, with an average of 12.1 per square foot. Not a single beetle was collected from one of the cages at this elevation.

EFFECT OF SIDE OF TREE ON EMERGENCE

Similarly, as with the effect of elevation, definite statements cannot be made concerning the effect of the side of the tree on the basis of only one season's records. However, these data show

that the emergence from limber pine was heavier on the south side of the trees. Here too, emergence started, reached it's peak, and ended sooner than on the north side. In lodgepole pine the conditions were just the reverse. The emergence was heavier, started, reached the peak, and ended sooner on the north side of the trees. No logical reason can be given for this peculiar emergence in lodgepole pine.

ASSOCIATED INSECTS

The fourth object of this study was to obtain information on the insects associated with the Black Hills beetle.

The interesting thing about the results of the first seasons collections is the comparatively small number of individuals as well as species collected. A comparison of this number is as follows:

	Dendroctonus ponderosae	All other species
Limber pine	4,606	276
Lodgepole pine	584	192

Table 8 shows the distribution and the total number of insects collected. Complete identifications have not been made in the majority of cases, and because of the few specimens available have not been sent in for determination.

SUMMARY

The important information obtained during the Black Hills beetle caging study is summarized below.

(1) The area selected was on Elk Mountain, Wyoming, outside the Medicine Bow National Forest boundary where conditions were

nearly ideal for such a study.

(2) A total of 45 cages, covering 90 square feet of bark surface, were placed on 27 trees - 13 lodgepole pine (46 square feet) and 14 limber pine (44 square feet). Fifteen cages were placed at each of three elevations - 8,000, 9,000, and 10,000 feet.

(3) The emergence from limber pine attacked in 1934 was approximately 800 percent greater than from lodgepole pine.

(4) A total of 4,606 beetles emerged from 28 square feet of limber pine giving an average of 164.5 beetles per square foot. The most beetles emerging from one square foot was 254 at 10,000 feet. The least number per square foot was 41 at 9,000 feet.

(5) Only 584 beetles emerged from 32 square feet of lodgepole pine giving an average of 18.2 per square foot. The most beetles emerging from one square foot was 77 at 10,000 feet. The least number per square foot was 0 at 9,000 feet.

(6) The first emergence from limber pine at 8,000 feet was about August 1st; the last on September 22; and the duration 47 days. From lodgepole pine the first emergence at 8,000 feet was about August 1st; the last on September 9; and the duration 34 days.

(7) At 9,000 feet the first emergence from limber pine was on August 7; the last on September 15; and the duration 40 days. From lodgepole pine the first emergence was on August 7; the last on September 15; and the duration 40 days.

(8) At 10,000 feet the first emergence from limber pine was on August 15; the last on October 12; and the duration 56 days. From lodgepole pine the first emergence was on August 15; the last on September 6; and the duration 53 days.

(9) A total of 50 parent adults reemerged from 16 square feet of limber pine attacked in 1935, with an average of 3.1 per square foot. Of these, 22 emerged from 2 square feet at 8, 000. feet.

(10) A total of 39 parent adults reemerged from 14 square feet of lodgepole pine attacked in 1935, with an average of 2.7 per square foot.

(11) The data showed that from limber pine the emergence was heavier, started, and reached it's peak sooner on the south side of the tree. In lodgepole pine these conditions were reversed, emergence was heavier, started, and ended sooner on the north side of the trees.

RECOMMENDATIONS

The collecting cans, removed during the winter, should be replaced early in the spring possibly in late April or early May.

Collections should be made at regular intervals.

It would be advisable to leave the original cages intact for another year to catch the Black Hills beetles requiring more than one year for development, as well as the associated insects which have not as yet emerged.

An attempt should be made to correlate the number of emerging beetles with the number of exit holes, and the number of emerging beetles with the original number of attacks.

Additional work should be done to determine whether or not parent adults reattack. This could be done by caging a tree or sections of green logs and introducing emerging parent adults.

In order to secure comparative emergence data additional areas should be selected in other parts of the region and representative trees caged. One of these areas which might work into the present program, is an area on Mullison Creek, northeast of the Brush Creek Ranger Station on the Medicine Bow National Forest. This area was visited with Ranger Riggs late in 1935 and he could give the exact location.

This is an area of mature lodgepole pine with a light Black Hills beetle infestation. It was suggested at the time that control work be withheld from this area so it could be cruised and a sample plot laid out and trees caged to secure information on a point suggested by field examinations and this caging study.

This point is, whether an infestation would maintain itself and increase in a stand of pure lodgepole pine without the aid of the larger number of beetles emerging from limber or ponderosa pine. The closest limber pine to this particular area, so far as known, is about 10 miles and would not be likely to interfere with this isolated infestation. It is possible that the supposition that the Black Hills beetle would not build up to any extent in lodgepole pine in southeastern Wyoming is erroneous. The establishment of such a plot should give information on this point.

It is further suggested that thermometers or thermographs be placed in the areas surrounding the cages to correlate emergence with temperature changes.

North

ELK MOUNTAIN

PASS CREEK

COAD MOUNTAIN

MEDICINE BOW NATIONAL FOREST BOUNDARY

PENNOCK MOUNTAIN

South

PHOTO NUMBER ONE

This photo shows the relationship of Elk Mountain, Wyoming to the Medicine Bow National Forest. The distance from the forest boundary to Pass Creek is approximately 4 miles. The distance from the camera to Elk Mountain is about 16 miles. The heaviest Black Hills beetle infestation is on the south and entire west portions of Elk Mountain, with a few scattered trees on Pennock Mountain.

North South

PHOTO NUMBER TWO

The west side of Elk Mountain, Wyoming from a distance of about 5 miles. The elevation in the foreground is about 7,000 feet, the peak of Elk Mountain is 11,162 feet. Our cages are placed at 3 elevations on this west side - 8,000, 9,000 and 10,000 feet - the highest being in the timber that appears to be at the top of the mountain.

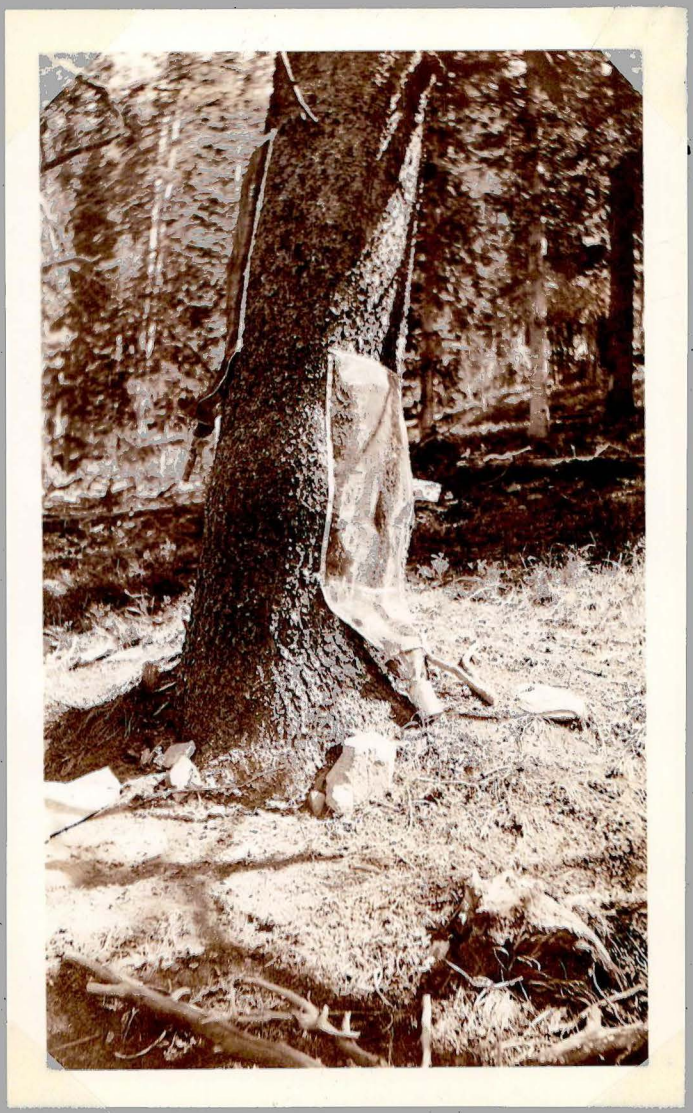


PHOTO NUMBER THREE

An infested Lodgepole Pine at 9,000 feet with 2 emergence cages attached. When 2 cages were placed on the same tree, the bottoms of the cages were placed the same distance from the ground. This tree is the only exception.

PHOTO NUMBER FOUR

A close-up view of an emergence cage, covering a surface 1 by 2 feet on an infested Limber Pine. The removable tin collecting can, into which the emerging beetles fall, is shown attached to a small funnel at the bottom. This cage is held in place with strips of $\frac{1}{2}$ inch galvanized iron. Although cotton packing was used beneath the edges of this cage, it is not necessary when iron strips are used.

TABLE NUMBER ONE

TOTAL EMERGENCE OF THE BLACK HILLS BEETLE FROM CAGED LIMBER PINE - NEW ADULTS

	8,000 Feet		9,000 Feet		10,000 Feet	
	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage
	# 4 - 268	# 4 - 451	# 9 - 343	# 9 - 366	# 12 - 509	# 12 - 433
	# 5 - 483	# 5 - 364	#10 - 81	#10 - 119	# 13 - 364	# 13 - 250
					# 14 - 204	# 14 - 371
Total Emergence	751	815	424	485	1,077	1,054
Square Feet of Bark Caged	4	4	4	4	6	6
Emergence Per Square Foot	188	204	101	121	180	176
Total Emergence	1,566		909		2,131	
Square Feet of Bark Caged	8		8		12	
Emergence Per Square Foot	195.7		113.6		177.6	
TOTAL EMERGENCE						4,606
SQUARE FEET OF BARK CAGED						28
EMERGENCE PER SQUARE FOOT						164.5

TOTAL EMERGENCE OF THE BLACK HILLS BEETLE FROM CAGED LODGEPOLE PINE - NEW ADULTS

	8,000 Feet		9,000 Feet		10,000 Feet	
	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage
	# 1 - 88	# 1 - 42	# 6 - 4	# 6 - 0	# 11 - 154	# 11 - 63
	# 2 - 31	# 2 - 5	# 7 - 13	# 7 - 5	# 15 - 14	# 15 - 23
	# 3 - 3	# 3 - 16	# 8 - 62	# 8 - 61	#	
Total Emergence	122	63	79	66	168	86
Square Feet of Bark Caged	6	6	6	6	4	4
Emergence Per Square Foot	20.3	10.5	13.1	11	42	21.5
Total Emergence	185		145		254	
Square Feet of Bark Caged	12		12		8	
Emergence Per Square Foot	15.4		12.1		31.7	
TOTAL EMERGENCE						584
SQUARE FEET OF BARK CAGED						32
EMERGENCE PER SQUARE FOOT						18.2

TABLE NUMBER TWO

THE DATES AND THE NUMBER OF DAYS AFTER THE START OF
THE BLACK HILLS BEETLE EMERGENCE ON WHICH IMPORTANT PERCENTAGES OCCURRED

Elevation	Tree Species	First Emergence South	First Emergence North	50 % Emergence South	50 % Emergence North	75 % Emergence South	75 % Emergence North	90 % Emergence South	90 % Emergence North	Last Emergence South	Last Emergence North
8,000 Feet	LP *	8-7-35	8-7-35	8-9-35	8-12-35	8-13-35	8-18-35	8-19-35	8-23-35	9-9-35	9-22-35
				3 **	6	7	12	13	17	34	47
	LPP***	8-7-35	8-7-35	8-9-35	8-11-35	8-14-35	8-15-35	8-21-35	8-21-35	9-9-35	8-30-35
				3	5	8	9	15	15	34	24
9,000 Feet	LP	8-7-35	8-7-35	8-23-35	8-20-35	8-27-35	8-23-35	8-31-35	8-29-35	9-15-35	9-15-35
				17	14	21	17	25	23	40	40
	LPP	8-7-35	8-7-35	8-15-35	8-15-35	8-22-35	8-21-35	8-28-35	8-25-35	9-15-35	9-15-35
				9	9	16	15	22	19	40	40
10,000 Feet	LP	8-15-35	8-18-35	8-28-35	9-2-35	9-2-35	9-10-35	9-11-35	9-14-35	10-6-35	10-12-35
				14	16	19	24	28	28	53	56
	LPP	8-15-35	8-21-35	8-31-35	8-28-35	9-8-35	9-2-35	9-13-35	9-10-35	10-6-35	10-6-35
				17	8	25	13	30	21	53	47

* Limber Pine ** Number of days after the start of emergence *** Lodgepole Pine

TABLE NUMBER THREE

BLACK HILLS BEETLE - PARENT -ADULT EMERGENCE FROM CAGED LEMBER PINE

	6,000 Feet		9,000 Feet		10,000 Feet	
	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage
	# 26 - 16	# 25 - 22	# 22 - 2	# 22 - 3	# 16 - 5	# 17 - 2
	#			# 23 - 0	# 20 - 0	
Total Emergence	16	22	2	3	5	2
Square Feet of Bark Caged	2	2	2	4	4	2
Emergence Per Square Foot	8	11	1	1	1	1
Total Emergence	38		5		7	
Square Feet of Bark Caged	4		6		6	
Emergence Per Square Foot	9.5		1		1.1	
TOTAL EMERGENCE						50
SQUARE FEET OF BARK CAGED						16
EMERGENCE PER SQUARE FOOT						3.1

BLACK HILLS BEETLE EMERGENCE FROM CAGED LODGEPOLE PINE - PARENT - ADULT EMERGENCE

	6,000 Feet		9,000 Feet		10,000 Feet	
	North Cage	South Cage	North Cage	South Cage	North Cage	South Cage
	# 24 - 3	#	# 21 - 2	# 21 - 11	# 19 - 2	# 18 - 11
	# 27 - 8	# 27 - 2	#			
Total Emergence	11	2	2	11	2	11
Square Feet of Bark Caged	4	2	2	2	2	2
Emergence Per Square Foot	2.7	1	1	5.5	1	5.5
Total Emergence	13		13		13	
Square Feet of Bark Caged	6		4		4	
Emergence Per Square Foot	2.1		3.2		3.2	
TOTAL EMERGENCE						39
SQUARE FEET OF BARK CAGED						14
EMERGENCE PER SQUARE FOOT						2.7

TABLE NUMBER FOUR

THE EMERGENCE OF THE BLACK HILLS BEETLE FROM LIMBER PINE - SOUTH CAGES,1935

	8,000 Feet					9,000 Feet					10,000 Feet					
Date	Tree # 4	Tree # 5	Total 2 Trees	% of Total	Total	% of Total	Tree # 9	Tree # 10	Total 2 Trees	% of Total	Total	% of Total	Tree # 12	Tree # 13	Tree # 14	Total 3 Trees	% of Total	Total	% of Total
8-7-35	237	93	330	41	330	41	2	1	3	.6	3	.6							
8-15-35	155	201	356	44	686	84	56	5	61	12.5	64	13		3	4	7	.6	7	.6
8-18-35	8	7	15	1.3	701	86	3	1	4	.8	68	14		3		3	.2	10	.9
8-21-35	26	38	64	7.9	765	94	83	29	112	23	180	37	5	46	46	97	9.3	107	10.3
8-25-35	15	15	30	3.7	795	97	115	36	151	31	331	68	50	58	124	232	22	339	32
8-30-35	10	4	14	1.7	809	99	65	37	102	21	433	88	123	63	94	280	27	619	58
9-2-35		2	2	.2	811	99.5	21	5	26	5.3	459	94	88	40	27	155	14.9	774	74
9-9-35		4	4	.5	815	100	11	3	14	2.8	473	96	92	15	23	130	12	904	87
9-15-35							10	2	12	2.4	485	99	56	6	44	106	10	1010	97
9-22-35							1		1	.2	486	99.5	15	4	6	25	2.4	1035	99
10-6-35							4		4	.7	490	100	2	4		6	.6	1041	99.5
10-12-35													1			1	.1	1042	100

THE EMERGENCE OF THE BLACK HILLS BEETLE FROM LIMBER PINE - NORTH CAGES 1935

	8,000 Feet					9,000 Feet					10,000 Feet					
Date	Tree # 4	Tree # 5	Total 2 Trees	% of Total	Total	% of Total	Tree # 9	Tree # 10	Total 2 Trees	% of Total	Total	% of Total	Tree # 12	Tree # 13	Tree # 14	Total 3 Trees	% of Total	Total	% of Total
8- 7-35	63	121	184	24.6	184	24.6	5		5	1.3	5	1.3							
8-15-35	83	271	354	47	538	72	123	9	132	31	137	32							
8-18-35	12	13	25	3.3	563	75	4	3	7	1.7	144	34	1	4	1	6	.5	6	.5
8-21-35	41	45	86	11.4	649	86	105	10	115	27	259	61	3	24		27	2.5	33	3
8-25-35	38	27	65	8.6	714	95	78	27	105	25	364	86	46	93	16	155	14	188	18
8-30-35	12	2	14	.9	728	97	16	8	24	5.7	388	91	87	97	34	218	21	406	39
9- 2-35	11	2	13	.7	741	98	4	15	19	4.5	407	96	70	21	27	118	11	524	50
9- 9-35	2		2	.2	743	99	4	5	9	2.1	416	98	112	51	41	204	19	728	69
9-15-35	4	2	6	.8	749	99.5	3	4	7	1.7	423	99	156	52	61	269	25	997	95
9-22-35	2		2	.2	751	100							28	4	13	45	4.3	1042	99
10-6-35							1		1	.1	424	100	2		58	7	.5	1047	99.5
10-12-35															1	1	.09	1048	100

TABLE NUMBER FIVE

THE EMERGENCE OF THE BLACK HILLS BEETLE FROM LODGEPOLE PINE - SOUTH CAGES,1935

	8,000 Feet							9,000 Feet							10,000 Feet			
Date	Tree # 1	Tree # 2	Tree # 3	Total 3 Trees	% of Total		% of Total	Tree # 6	Tree # 7	Tree # 8	Total 3 Trees	% of Total		% of Total	Tree # 11	% of Total		% of Total
8- 7-35	13	3	10	26	41		26			2	2	3		3	3			
8-15-35	19	4	1	24	38		50		4	29	33	50		35	53	4	6.1	4	6.1
8-18-35	3			3	3.8		53			2	2	3		37	56				
8-21-35	3		1	4	6.5		57			9	9	13		46	70	7	11	11	17
8-25-35	2		1	3	4.8		60		1	8	9	13		55	83	3	4.7	14	22
8-30-35	1	1		2	3.1		62			8	8	12		63	95	16	25	30	48
9- 2-35										2	2	3		65	99	8	13	38	60
9- 9-35	1		1	1	1.6		63									11	17	49	78
9-15-35										1	1	1.5		66	100	11	17	60	95
9-22-35																2	3.2	62	98
10-6-35																1	1.6	63	100

THE EMERGENCE OF THE BLACK HILLS BEETLE FROM LODGEPOLE PINE - NORTH CAGES ,1935

	8,000 Feet							9,000 Feet							10,000 Feet			
Date	Tree # 1	Tree # 2	Tree # 3	Total 3 Trees	% of Total		% of Total	Tree # 6	Tree # 7	Tree # 8	Total 3 Trees	% of Total		% of Total	Tree # 11	% of Total		% of Total
8- 7-35	25	4	2	31	25		31		2	4	6	7.6		6	7.6				
8-15-35	38	22		60	50		91		4	29	33	42		39	49				
8-18-35	4			4	3.3		95		1	6	7	8.9		46	58				
8-21-35	9	3		12	9.8		107	2	2	13	17	22		63	80	7	4.7	7	4.7
8-25-35	9	1		10	8.2		117	2	3	4	9	11		72	91	34	23	41	28
8-30-35	3	1		4	3.3		121		1	4	5	63		77	98	54	37	95	65
9- 2-35																16	11	111	75
9- 9-35																18	12	129	88
9-15-35										2	2	2.5		79	100	13	8.8	142	97
9-22-35																1	.7	143	98
10-6-35																4	2.7	147	100

TABLE NUMBER SIX

COMBINED TOTAL OF THE EMERGENCE FROM NORTH AND SOUTH CAGES
LIMBER PINE - 1935

	8,000 Feet				9,000 Feet				10,000 Feet			
Date	Total 7 Trees	% of Total	Total	% of Total	Total 7 Trees	% of Total	Total	% of Total	Total 7 Trees	% of Total	Total	% of Total
8- 7-35	514	33	514	33	8	.08	8	.08				
8-15-35	710	45	1224	78	193	21	201	22	7	.03	7	.03
8-18-35	40	2.5	1264	81	11	1.2	212	23	9	.04	16	.8
8-21-35	150	9.5	1410	90	227	25	439	48	134	6.3	150	7.1
8-25-35	95	6.1	1505	96	256	28	695	76	397	19	547	25
8-30-35	28	1.8	1533	98	126	14	821	90	498	23	1045	49
9- 2-35	15	.9	1548	99	45	4.9	866	95	273	13	1318	62
9- 9-35	6	.3	1554	99.5	23	2.5	889	97.5	334	16	1652	78
9-15-35	6	.3	1560	99.8	19	2.1	908	99.4	385	18	2037	96
9-22-35	2	.1	1562	100	1	.1	909	99.5	70	3.3	2107	99
10-6-35					5	.5	914	100	11	.5	2118	99.5
10-12-35									2	.01	2120	100

COMBINED TOTAL OF THE EMERGENCE FROM THE NORTH AND SOUTH CAGES
LODGEPOLE PINE - 1935

	8,000 Feet				9,000 Feet				10,000 Feet			
Date	Total 7 Trees	% of Total	Total	% of Total	Total 7 Trees	% of Total	Total	% of Total	Total 7 Trees	% of Total	Total	% of Total
8- 7-35	57	31	57	31	8	5.5	8	5.5				
8-15-35	84	45	141	77	66	45	74	51	4	1.9	4	1.9
8-18-35	7	3.8	148	80	9	6.2	83	57				
8-21-35	16	8.7	164	89	26	18	109	75	14	6.7	18	8.6
8-25-35	13	7	177	96	18	12	127	87	37	18	55	26
8-30-35	6	3.3	183	99.5	13	9	140	96	70	33	125	60
9- 2-35					2	1.4	142	98	24	11.5	149	71
9- 9-35	1	.5	184	100					29	14	178	85
9-15-35					3	2.1	145	100	23	11	201	96
9-22-35									3	1.4	204	98
10-6-35									5	2.4	209	100

TABLE NUMBER SEVEN

THE SIZE AND DISTRIBUTION OF THE CAGED TREES -1935

Tree Number	Tree Species	D.B.H.	Height	Number of Cages	Elevation	Slope	Exposure
1	Lodgepole Pine	14	60	2	8,000 Feet	W	W
2	" "	12	50	2	" "	"	"
3	" "	10	50	2	" "	"	"
24	" "	12	45	1	" "	"	N
27	" "	18	60	2	" "	"	W
4	Limber Pine	16	45	2	" "	W	S
5	" "	12	40	2	" "	"	"
25	" "	14	30	1	" "	"	"
26	" "	16	40	1	" "	"	W
9	" "	10	35	2	9,000 Feet	N	N
10	" "	12	40	2	" "	N	N
22	" "	20	40	2	" "	S	S
23	" "	14	30	1	" "	"	"
6	Lodgepole Pine	10	35	2	" "	W	N
7	" "	14	50	2	" "	"	"
8	" "	12	40	2	" "	"	"
21	" "	20	60	2	" "	"	S
11	" "	16	35	2	10,000 Feet	W	W
15	" "	12	40	2	" "	"	"
18	" "	14	35	1	" "	"	S
19	" "	16	50	1	" "	"	W
12	Limber Pine	12	25	2	" "	"	"
13	" "	8	25	2	" "	"	"
14	" "	14	30	2	" "	"	"
16	" "	16	30	1	" "	"	"
17	" "	14	22	1	" "	"	S
20	" "	16	30	1	" "	"	E

		Av.	Av.		
13	Lodgepole Pine	13	47.7	23	
14	Limber Pine	13	32.9	22	

TABLE NUMBER 8

LIST OF ASSOCIATED INSECTS - 1935

LIMBER PINE - ADULT FORMS

COLEOPTERA

SCOLYTIDAE

1 Dendroctonus ponderosae Hopk. - 4,606
25 Ips integer Eich. - 7
9 Pityophthorus sp. - 45
4,658

STAPHYLINIDAE sp. - 2

TENEBRIONIDAE

3 Hypophloeus substriatus Lec. - 46

CERAMBYCIDAE

12 Asemum atrum Esch - 1
13 Acanthocinus spectabilis(Lec) - 2
3

16 Coleoptera sp. - 4
18 Coleoptera sp. - 1
24 Coleoptera sp. - 1
8

5 HEMIPTERA sp. - 1
10 Hemiptera sp. - 1
2

22 Homoptera sp. - 10
19 Homoptera sp. - 2
12

HYMENOPTERA

BRACONIDAE

7 Coeloides sp. - 3

17 Hymenoptera sp. - 1
4

14 Arachnida sp - 1
20 Arachnida sp. - 30
31

LIMBER PINE - LARVAL FORMS

COLEOPTERA

2 Cleridae sp. - 32
9 Coleoptera sp. - 9

11 Diptera sp. - 50

23 Hymenoptera sp. - 1
21 Hymenoptera sp. - 1

LODGEPOLE PINE - ADULT FORMS

COLEOPTERA

SCOLYTIDAE

1 Dendroctonus ponderosae Hopk. - 584
10 Pityophthorus sp. - 15
599

TENEBRIONIDAE

4 Hypophloeus substriatus Lec. - 23

CERAMBYCIDAE

14 Asemum atrum Esch - 2

CLERIDAE

15 Enoclerus sp. - 2

11 Coleoptera sp. - 3

13 Diptera sp. - 1
7 Lepidoptera sp. - 1
8 Lepidoptera sp. - 3
12 Lepidoptera sp. - 3

HYMENPOTERA

BRACONIDAE

19 Coeloides sp. - 42

16 Braconidae sp. - 1
5 Braconidae sp. - 1

6 Thysanoptera sp. - 56

18 Arachnida sp. - 1
20 Arachnida sp. - 30
21 Arachnida sp. - 1

LODGEPOLE PINE - LARVAL FORMS

COLEOPTERA

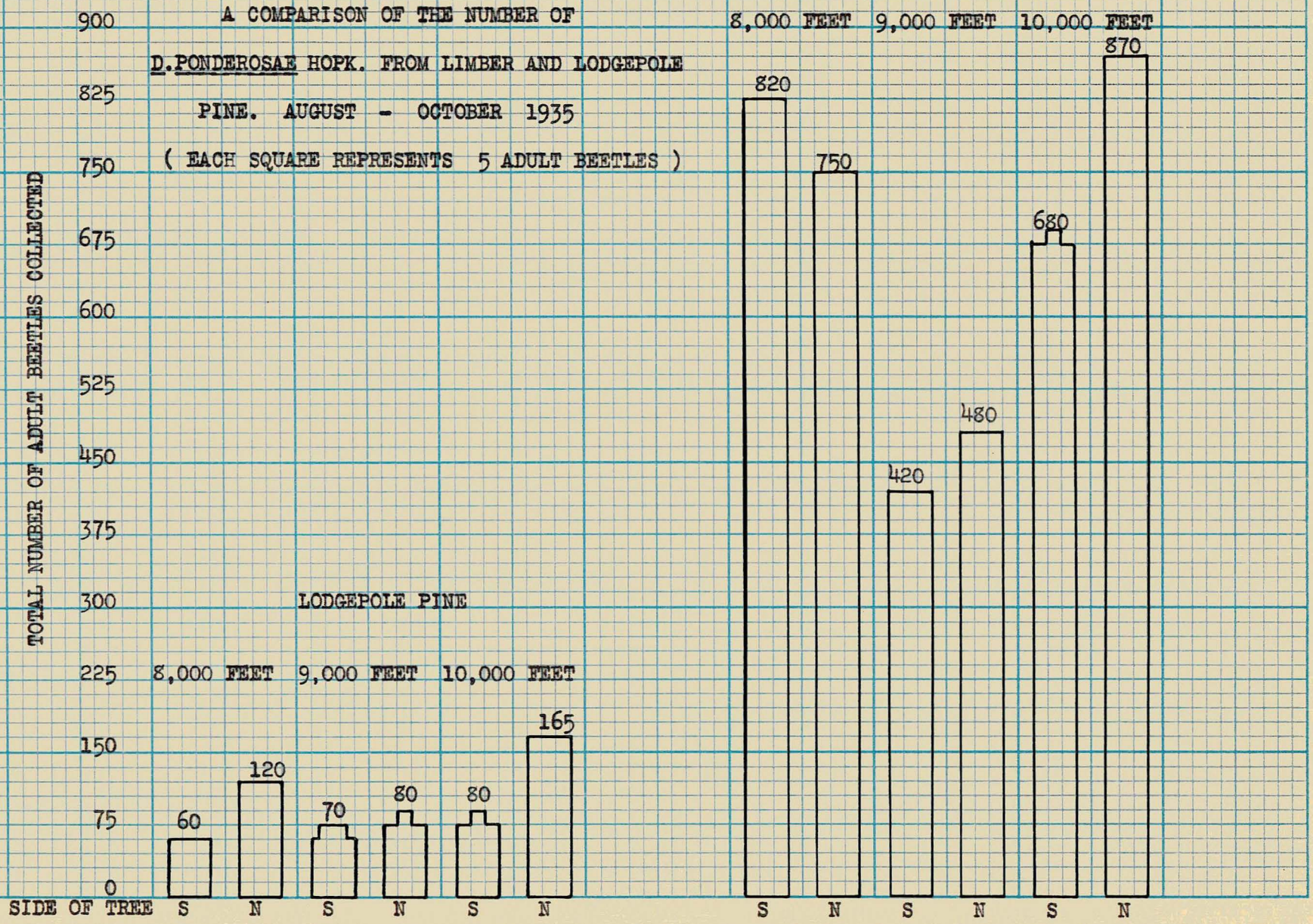
2 Cleridae sp. - 8
17 Coleoptera sp. - 1
24 Coleoptera sp. - 2

9 Diptera sp.(?) - 2

CHART NUMBER ONE

A COMPARISON OF THE NUMBER OF D.PONDEROSAE HOPK. FROM LIMBER AND LODGEPOLE PINE. AUGUST - OCTOBER 1935

(EACH SQUARE REPRESENTS 5 ADULT BEETLES)



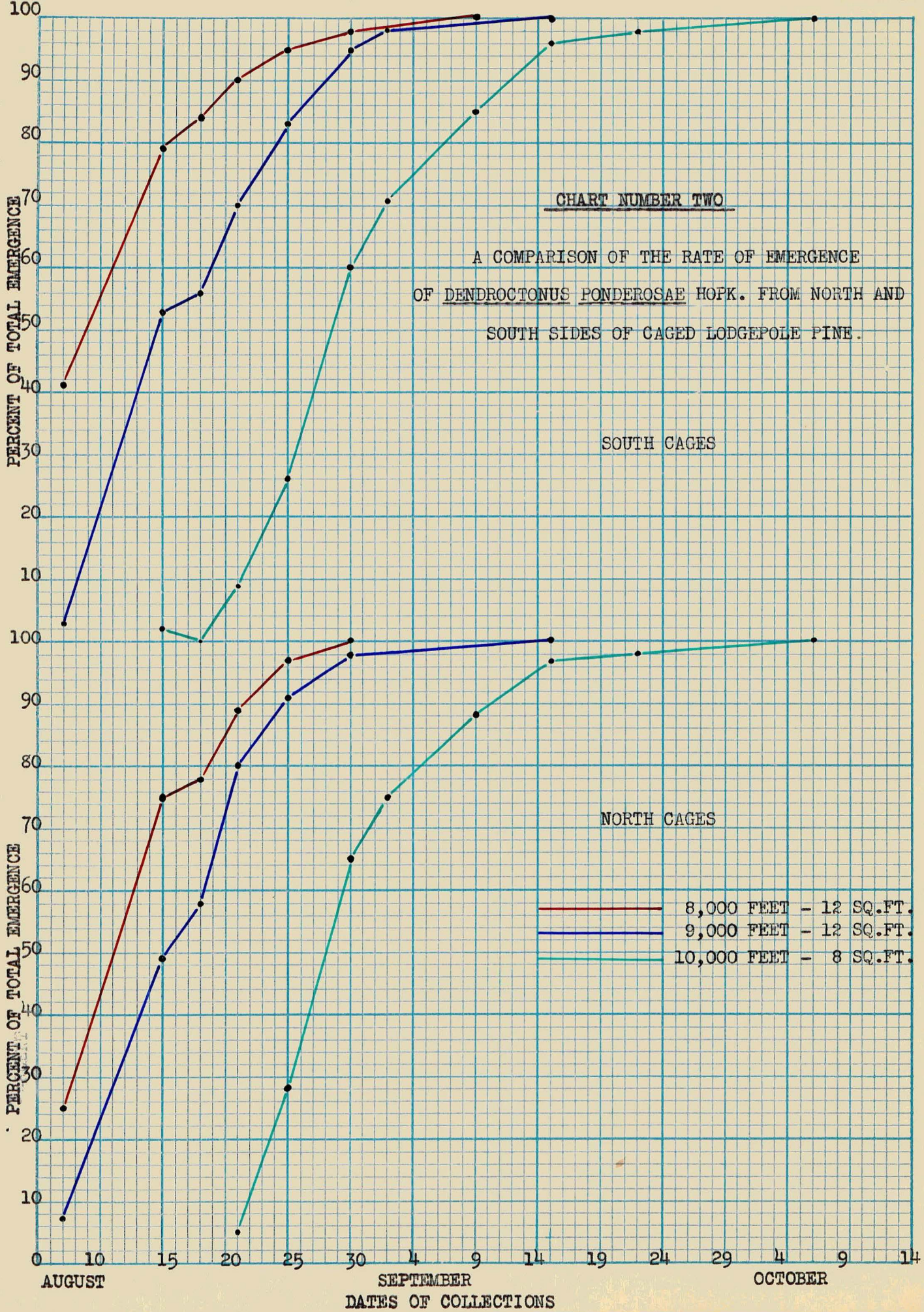


CHART NUMBER TWO
A COMPARISON OF THE RATE OF EMERGENCE
OF DENDROCTONUS PONDEROSAE HOPK. FROM NORTH AND
SOUTH SIDES OF CAGED LODGEPOLE PINE.
SOUTH CAGES
NORTH CAGES
8,000 FEET - 12 SQ.FT.
9,000 FEET - 12 SQ.FT.
10,000 FEET - 8 SQ.FT.
PERCENT OF TOTAL EMERGENCE
PERCENT OF TOTAL EMERGENCE
100
90
80
70
60
50
40
30
20
10
0
10
15
20
25
30
4
9
14
19
24
29
4
9
14
AUGUST
SEPTEMBER
OCTOBER
DATES OF COLLECTIONS

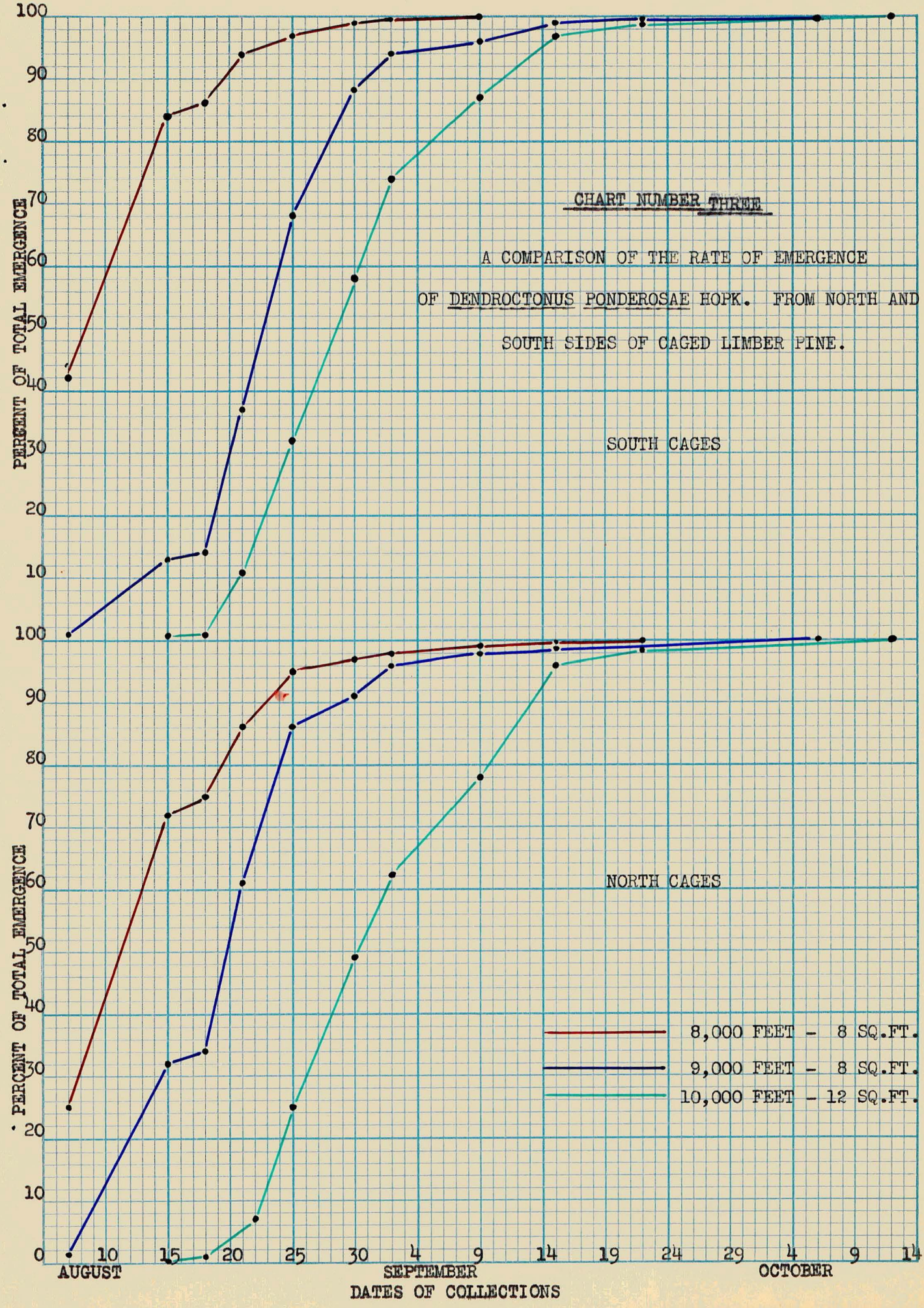


CHART NUMBER THREE
A COMPARISON OF THE RATE OF EMERGENCE OF DENDROCTONUS PONDEROSAE HOPK. FROM NORTH AND SOUTH SIDES OF CAGED LIMBER PINE.
SOUTH CAGES
NORTH CAGES
PERCENT OF TOTAL EMERGENCE
PERCENT OF TOTAL EMERGENCE
0
10
20
30
40
50
60
70
80
90
100
AUGUST
SEPTEMBER
OCTOBER
DATES OF COLLECTIONS
8,000 FEET - 8 SQ.FT.
9,000 FEET - 8 SQ.FT.
10,000 FEET - 12 SQ.FT.

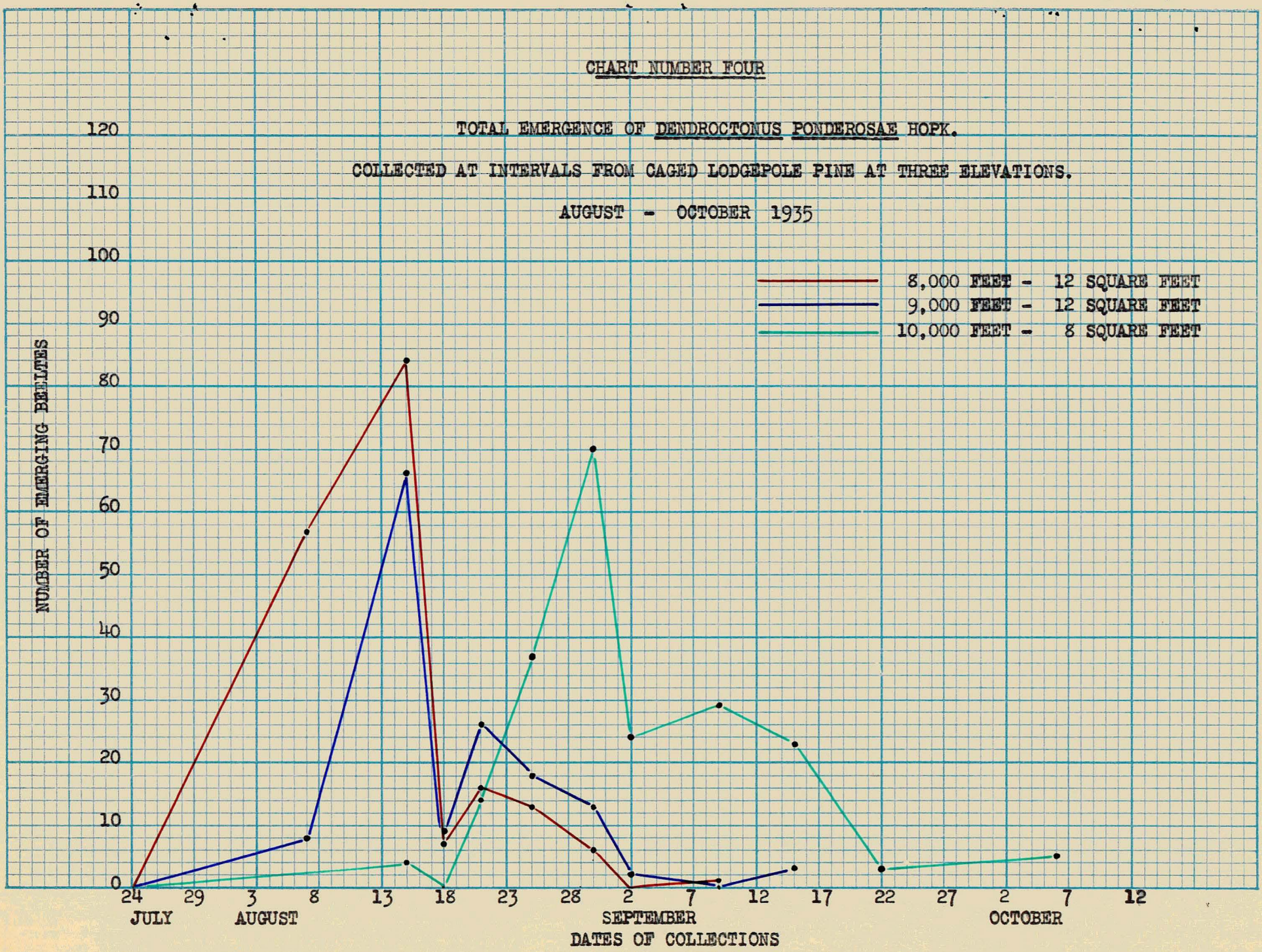


CHART NUMBER FOUR
TOTAL EMERGENCE OF DENDROCTONUS PONDEROSAE HOPK.
COLLECTED AT INTERVALS FROM CAGED LODGEPOLE PINE AT THREE ELEVATIONS.
AUGUST - OCTOBER 1935
8,000 FEET - 12 SQUARE FEET
9,000 FEET - 12 SQUARE FEET
10,000 FEET - 8 SQUARE FEET
NUMBER OF EMERGING BEETLES
0
10
20
30
40
50
60
70
80
90
100
110
120
24 29 3 8 13 18 23 28 2 7 12 17 22 27 2 7 12
JULY
AUGUST
SEPTEMBER
OCTOBER
DATES OF COLLECTIONS

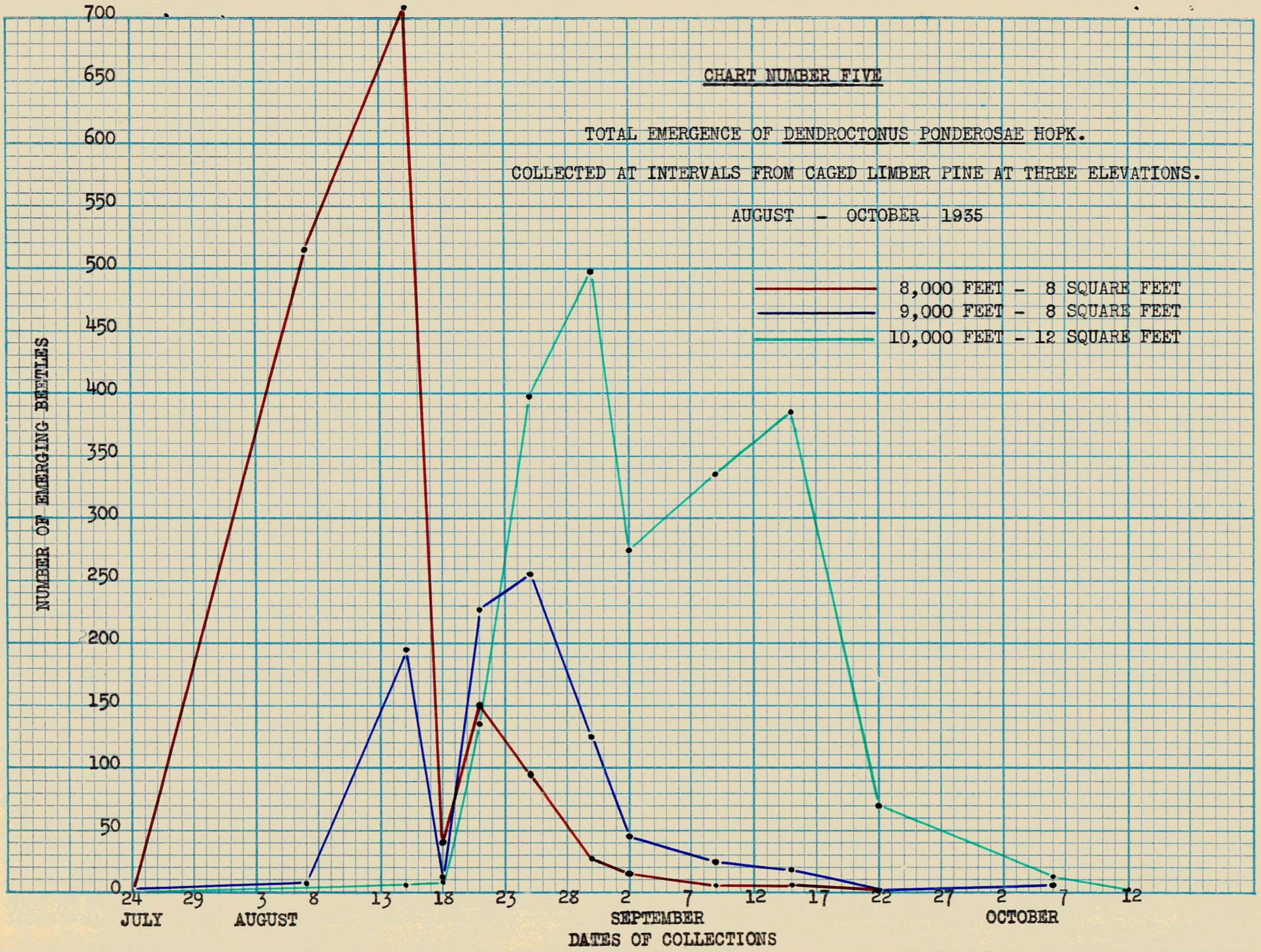


CHART NUMBER FIVE
TOTAL EMERGENCE OF DENDROCTONUS PONDEROSAE HOPK.
COLLECTED AT INTERVALS FROM CAGED LIMBER PINE AT THREE ELEVATIONS.
AUGUST - OCTOBER 1935
8,000 FEET - 8 SQUARE FEET
9,000 FEET - 8 SQUARE FEET
10,000 FEET - 12 SQUARE FEET
NUMBER OF EMERGING BEETLES
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
24 29 3 8 13 18 23 28 2 7 12 17 22 27 2 7 12
JULY
AUGUST
SEPTEMBER
OCTOBER
DATES OF COLLECTIONS